The mornings of the wet season are, as a rule, cool and fresh. Preceding and during the afternoon and night rains, however, the atmosphere is sultry and oppressive, and in the low-lying Atlantic end of the Canal Zone the heat is particularly trying. In the dry season of the winter and early spring months temperatures are usually pleasant, except during the prevalence of "northers" when the weather is sometimes disagreeably cool.

At no point in the Canal route does the elevation above sea level exceed 300 feet. The entire strip may, therefore, be placed in the "hot zone", a term that is applied to portions of the Central American coast districts that are less than 300 or 400 feet above the level of the sea. The Atlantic, or Caribbean Sea, side of the Isthmus is, however, lower, hotter, more humid, and more malarial than the Pacific side. At Colon the April rainfall averages about 36.5 inches, which equals the annual rainfall in the Middle Atlantic States of the United States. The November rainfall at Colon is nearly 23 inches, and the so-called August dry interval yields about 15 inches. On the watershed the monthly rainfall amounts to about 13 inches in May, September, October, and November, with a maximum of 14 inches in August. At Panama the maximum, about 12 inches, occurs in November, and 7 to 9 inches falls monthly from May to October, the least amount during this period being about 7 inches, in August. Daily rainfalls of 5 to 7 inches and hourly amounts of 1 to 2 inches are not uncommon in the Canal Zone during the wet season.

In plans for the construction and operation of the Canal the importance of the study of the vicissitudes of Panama rainfall can not be overestimated. The rainfall element does not enter so largely into the problem of a sea-level canal; in a lock canal, however, whose feeders are subject to sudden and violent floods, a due consideration of the variability, intensity, and duration of rainfalls, and of possible periodicities in years of excessive rains, is of the utmost importance. Periodicities in maximum and minimum rainfall periods are most likely to be defined in the equatorial rain belt, for in this region the association with terrestrial and solar causes of meteorological effects is undoubtedly the most apparent, and it is here that variations in primary causes can be the more readily detected by means of observed facts. In an adjustment of available Central American rainfall observations made in 1895, Professor Harrington[1] noted a succession of maxima and minima of annual rainfalls, with intervals of recurring years of unusually heavy rains that ranged from five to eight years, and an average interval between the maxima of six years.

Aside from the value that may be attached by meteorologists to investigations of the periods of excess and deficiency in Panama rainfall, the results of investigations of this kind are calculated to be of practical value to engineers and of interest to the American public. In short, the construction of a lock canal in a part of the equatorial rain belt that is visited by seasonal downpours, which at intervals of several years are likely for periods of days and perhaps months to be abnormally heavy, presents a new and most important problem in canal construction.

[1] Phil. Soc. of Wash., Bul., Vol. XIII, pp. 1–30.

OBSERVATION OF CLOUD ALTITUDES AT NIGHTTIME.

In 1872 the Editor had occasion to make a report to the Chief Signal Officer on the importance of observing clouds, their altitudes, motions, and phenomena in greater detail than was common at that time. Among many methods recommended he enumerated the use of small balloons, filled with hydrogen gas, each carrying a long thread, by means of which its initial vertical velocity and its subsequent altitude could be determined at any time, whenever it entered or emerged from a cloud. The necessary balloons and instructions for using this method were furnished for the use of the arctic expedition of the schooner *Florence* in 1877.

Among other methods for permanent use at a fixt station, and as almost the only method appropriate for work at nighttime, he urged that within a few miles of an observer, a searchlight should be stationed, pointing vertically upward, and thus illuminating a circular patch of cloud or haze at the zenith.

The above methods are also described on pages 311 and 323 of the editor's "Meteorological apparatus and methods". He has often urged that this latter method of observation at nighttime is one of great value, likely to give us many new ideas as to the growth and structure of clouds. It is, therefore, with peculiar pleasure that we learn from the Geographical Journal, February, 1907, that Dr. J. Reden, assistant at the astronomical observatory at Vienna, has independently hit upon the same method, making use of the electric reflectors of the Leuchtbrunnen, or luminous fountain, erected at a point on the Ringstrasse, about a mile from the observatory. The observer has merely to measure the apparent angular altitude of the center of the luminous spot in the sky. The tangent of this angle, multiplied by the distance of the vertical beam of light, gives the linear height of the cloud. The first measurements were made June 14–24, 1906, and elevations between 5100 and 33,000 feet were soon measured. When the lower layer of clouds is thin it has become possible to detect three successive layers. The writer adds:

> The new method surpasses in exactitude the most trustworthy of the methods hitherto applied, viz, the photogrammetric, determining as it does the altitude in question with positive accuracy. It is hoped to start a systematic course of such observations in other parts of the earth as well. There is no doubt that not only for science, but also for practical weather forecasts, such observations will prove highly serviceable.

FOG ON THE NEWFOUNDLAND BANKS.[1]

By C. T. BRODRICK. Dated Harvard University, Cambridge, Mass., March 22, 1907.

During the greater part of the year the route for high-powered steamers between Nantucket Lightship and Fastnet or the Scilly Islands crosses the forty-seventh meridian to the south of latitude 43° north, making a considerably greater distance to be traversed by thus avoiding the Grand Banks. This circuitous route is taken because of the fog and the ice found in this district during the spring and summer months. Numerous collisions with other vessels and with icebergs occur every year, and some accidents in the past have been accompanied by large loss of life.

The occurrence of fog about the coasts of Newfoundland and farther north was noted by some of the earliest explorers of the regions—Cook, Ross, Parry, and others.[2] They remarked on its density, that it did not extend to any great height above the water, and that it was most prevalent with southerly winds. Some interesting speculations on the causes of these fogs are set forth at considerable length in Henry Ellis's "Voyage to Hudson's Bay," (1748).[3] His fantastic theories are in strange contrast with our present ideas, even with his own considerable accuracy of observation.

In 1822 Scoresby[4] published some data which he had accumulated during the previous summer. His general conclusions were that fogs are more prevalent during the summer months, that they have an average thickness of from 150 to 250 feet, and that they are accompanied by inversions of temperature.

[1] This article was prepared as a part of my college work in an advanced course in meteorology and climatology, under Prof. R. DeC. Ward. My original intention was to add some charts embodying the information kindly sent me by Mr. James Page, of the U. S. Weather Bureau, but the present work is principally bibliographic and historical. The article by Mr. Proctor, in the January, 1907, Review, was not available for me until after I had finished this work.

[2] Cf. Bibliography under Muncke.

[3] Cf. Bibliography: Ellis.

[4] Cf. Bibliography: Scoresby.

He thought they were caused by the chilling of warm, damp air thru contact with the ice.

With the exception of a few scattered articles which added nothing new, little was written on these subjects down to 1875.[5] In 1877 an article by Neumann[6] gave an excellent summary of the facts known at that time and the theories as to the causes of the fog. He noted particularly the effect of the proximity of the Gulf Stream and the Labrador current, the vast amount of floating ice, and the prevailing winds, and he also suggested that the temperature of the water should be the best warning to vessels in a fog of the proximity of ice fields or bergs.

During the next ten years considerable interest was taken in the subject and several papers were printed. The work of two men deserves special notice. In a series of articles in the MONTHLY WEATHER REVIEW[7] Prof. E. B. Garriott outlined the conditions governing the prevalence of fog in relation to the passage of cyclones and anticyclones north of latitude 35° north, and suggested the feasibility of predicting fog and issuing forecasts for outgoing steamers.

Two years later, in 1889, J. P. Finley[8] published a "Sailor's Handbook", in which he quoted from Professor Garriott's word, adding a series of charts showing the average and extreme limits of fog areas, based on data accumulated during the previous 32 months.

By far the most complete discussion of the subject is an article by Dr. Gerhard Schott,[9] entitled "Die Nebel der Neufundland Banke". With the addition of an article in the Annalen for 1904 on the relation of fog to wind, it expresses completely the present views, which may be briefly summarized as follows:

These fogs occur roughly over the area inclosed on the maps by the 200-fathom line, forming two centers of maximum frequency, one over the Grand Banks, southeast of Newfoundland, the other east of Massachusetts Bay. Over the greater part of this district, from May to August, more than 60 per cent of the total number of hours of observation are foggy. The minimum occurs in February. Southerly to westerly winds of a force 3 or 4 on the Beaufort scale are the most favorable to fog formation. Warm air from over the ocean, heavily charged with moisture, is thus brought in contact, within a distance of less than 300 miles, with colder water at a temperature of 30° F., and the formation of fog results. These conditions occur in the southeastern quadrant of a cyclone which leaves the States north of latitude 40° north. After the passage of the low area northwest winds follow, and these are accompanied by clearing weather. During the winter the close succession of cyclonic and anticyclonic areas prevents the long-continued fogs characteristic of the stagnant atmospheric conditions of the summer. Moreover, the prevailing winds during the summer are from a southerly quadrant, while those of the winter are from the northwest.

The importance of collecting data on these fogs and charting them, has been recognized by most of the nations whose shipping is affected. Pilot charts on which the occurrence of fog is shown are published monthly by Germany, Great Britain, and the United States.

In 1880 the Deutsche Seewarte[10] published the first of its "Resultate Meteorologischer Beobachtungen", more often called the "Quadrat Arbeit", which contain the results for 1-degree squares of all meteorological observations reported by German and Dutch ships in the North Atlantic. One column is devoted to the duration of fogs in hours, another to the number of "observation watches". As these watches are of the customary 4-hour interval, it is necessary to multiply their number by four to get the total number of hours of observation for use as a basis of computation. The publication of these Quadrat-Arbeiten has been continued to cover the entire North Atlantic in the region of the transatlantic steamship routes. It is these data which Doctor Schott used in preparing his monthly charts referred to above. The original source of the data is in all cases the meteorological logs furnished the captains of all German ships. The logs are of two kinds, a large one, the "Meteorologisches Tagebuch", and a smaller one, the "Kleines Wetterbuch". In both the occurrence of fog is noted under the head of "Wetter" and its duration and density under "Besondere Bemerkungen". The Deutsche Seewarte also publishes charts in the "Segelhandbuch"[11] and "Dampferhandbuch"[12] for the North Atlantic Ocean in which these data are grouped in 5-degree squares. On the German pilot charts fog is shown by different shadings covering areas of 10 to 25 per cent, 25 to 50 per cent, and more than 50 per cent, respectively.

A set of charts published by the Netherlands,[13] on which fog is also shown in this way, were compiled from the German data, except in low latitudes where the Dutch data were used.

On the British pilot charts of the North Atlantic and Mediterranean the areas of maximum fog frequency are shown similarly by shading areas of 10, 25, and 50 per cent. In reply to questions regarding the source of the data the following statement was received from the British Meteorological Office:

> The German data given in 1-degree squares were grouped by us in 5-degree squares, and our own data were taken out for areas of 5° longitude to 1° latitude. For latitudes north of 50° north the data were extracted from meteorological logs contributed by captains of the merchant marine to this office.

In these logs fog is recorded under the head of "Weather" and "Remarks", as in the German logs.

The first pilot charts issued by the United States Navy in 1884 contained no graphical indications of fog, tho the occurrence of fog during the previous month was noted in the margin. In August, 1887, the belts where fog had occurred were indicated by one grade of shading. In 1891 areas of "probable frequent fog" were also shaded. In July, 1895, a series of inset charts were published on the back of the pilot chart for that month, showing the fog reported during 1894. The track of each ship, with the date of entering and leaving fog and its character, was noted. In 1899 the area of fog was shown by different shading for each 10 per cent variation. In 1902 the first of the present form of inset charts was published. These show for 1-degree squares the percentage of fog as reported since 1894. Mr. James Page, formerly editor of these pilot charts, but now chief of the Division of Ocean Meteorology, U. S. Weather Bureau, in writing of the manner in which the figures were obtained, says:

> The reports from which this information is derived give the date and position of entrance into the fog, and the date and position of emergence from it. The fog is plotted as present upon the given date within the 1-degree square which the vessel traverses during the interval. Having obtained for the given month and for the given square the total number of days on which fog was reported, the number is divided by 30 or 31, as the case may be, to obtain the percentage. The figures on the chart are the average of several years thus treated.
>
> This method assumed that fog was present only on dates when it was actually reported, and that it was not present on the remaining dates. The exprest percentages are thus always less than the truth, especially for those squares within which observations are infrequent. In the immediate vicinity of the transatlantic routes the figures are probably of fair accuracy. In regions which are rarely visited by reporting vessels, such as that immediately to the east of Newfoundland, they have no value whatever.

[5] The occurrence of fog on the coast from New Jersey to Maine was frequently forecast in the early weather probabilities.—EDITOR.

[6] Cf. Bibliography: Neumann.

[7] Cf. Bibliography: Garriott.

[8] Cf. Bibliography: Finley.

[9] Cf. Bibliography: Deutsche Seewarte (Annalen).

[10] Cf. Bibliography: Deutsche Seewarte.

[11] Cf. Bibliography: Deutsche Seewarte.

[12] Cf. Bibliography: Deutsche Seewarte.

[13] Cf. Bibliography: Utrecht.

The "reports" which Mr. Page refers to are special blanks on the back of the meteorological logs furnished for use of navigators by the Weather Bureau, on which the civil date, the ship's time, latitude, longitude, the temperature of the air and water, and the character of the fog are entered. Fog is also noted in these logs under the head of "Weather experienced".

After a careful review of the existing charts of fog distribution over the North Atlantic, it seems to the writer that the German method of obtaining the percentages of fog with reference to the total number of hours of observation is on the whole preferable, altho neither method is perfectly accurate and satisfactory.

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Limit of fog areas in the North Atlantic. Oct., 1886, Dec., 1887. Cf. E. B. Garriott.

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Verzameling van kaarten.... mist. etc., uitgegeven.... Utrecht in 1862.

Also the standard text-books by Allingham, Davis, Findlay, Hann, Kaemtz, Loomis, Russell, Scott, etc.

WEATHER BUREAU MEN AS EDUCATORS.

The following lectures and addresses by Weather Bureau men have been reported:

Mr. Al. Brand, February 12, 1907, before certain residents of Evansville, Ind., on "Instruments used and work done by the U. S. Weather Bureau".

Mr. G. R. Oberholzer, February 21, 1907, before the Chamber of Commerce, Erie, Pa., on "The service of the Weather Bureau".

Mr. M. V. Robins, January 14, 1907, before the Men's Club of Plymouth Congregational Church, Omaha, Nebr., on "The Weather Bureau and its work".

Mr. M. R. Sanford, February 19, 1907, before the Current Events Club, Syracuse, N. Y., on "Current events in the atmosphere".

Mr. J. Warren Smith, of the Columbus, Ohio, office, February 6, 1907, before a farmers' institute at Jeffersonville, Ohio, on "The work of the Weather Bureau".

Mr. J. F. Voorhees, February 21, 1907, before the students of horticulture, at the University of Tennessee, Knoxville, on "Frost protection"; also February 22, 1907, before the students of the North Knoxville High School on "Weather forecasting".

Classes from universities, academies, and schools have visited Weather Bureau offices to study the instruments and equipment and receive informal instruction, as reported from the following offices:

Buffalo, N. Y., February 15 and 18, 1907, pupils from Public Schools Nos. 6 and 54.

Columbus, Ohio, February 8, 1907, a class in physical geography from the Central High School; February 9, 1907, the class in agriculture (short course), from Ohio State University; February 15 and 20, 1907, sections of the physical geography class from the South High School.

Fort Worth, Tex., February 13, 1907, the graduating class of Saint Ignatius Academy.

Los Angeles, Cal., February 15, 1907, the physical geography class of the Gardena High School.

Mobile, Ala., February 7, 1907, the graduating class of Barton Academy.

Oklahoma, Okla., February 8, 1907, the physical geography class of the Epworth University Academy.

Raleigh, N. C., February 6, 1907, the physical geography class of Peace Institute.

Springfield, Mo., February 2, 1907, the physical geography class of Drury College; February 20, 1907, the physical geography class of Springfield High School.

Syracuse, N. Y., February 12, 1907, the physical geography class of Jordan High School.

RECENT PAPERS BEARING ON METEOROLOGY.

H. H. KIMBALL, Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——

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Barus, Carl. Changes of the colloidal nucleation of dust-free wet air in the lapse of time. p. 202–210.

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